

Figure 3.3.1. Comparison of the percent of the state's coastal habitat represented by various sediment quality conditions and integrated sediment quality scores.

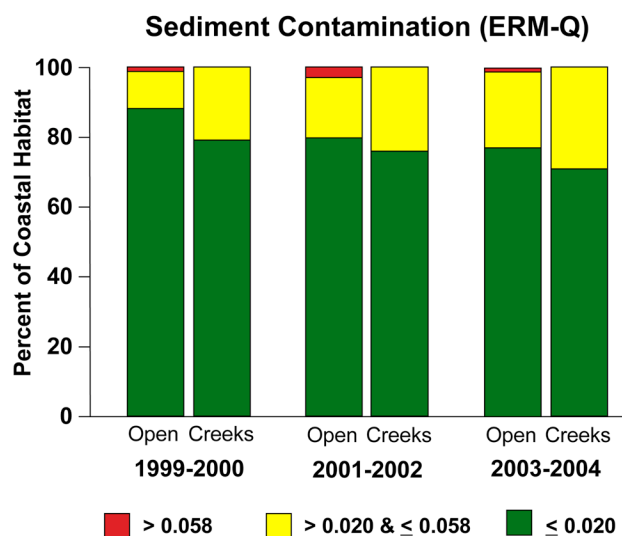


Figure 3.3.2. Change in ERM-Q in open water and tidal creek habitat since the start of SCECAP monitoring in 1999.

Toxicity Bioassays

Sediments may contain a wide range of contaminants, but the ability of those contaminants to negatively impact healthy biological communities depends on their availability to the resident fauna as well as interactive effects among the contaminants. Bioassays provide a means of determining the biological relevance of contaminant loads by examining the performance of living organisms in samples of native sediment (Ringwood and Keppler, 1998).

This SCECAP study applied three bioassays simultaneously—Microtox® bacterial growth, seed clam growth and amphipod survivorship—in order to provide a weight of evidence estimate of sediment

toxicity to benthic fauna. Positive test results in at least two of the three assays indicates a high probability of toxic sediments, positive results in only one of the three assays indicates possible evidence of toxic sediments and no positive results indicates non-toxic sediments. Using these guidelines, 8% of the open water and 7% of the tidal creek habitat in South Carolina had a high probability of containing toxic sediments, and an additional 45% of open water and 58% of tidal creek habitat had evidence of possible toxicity (Figure 3.3.1).

Using the data available from all six years of SCECAP, we examined the ability of the bioassays to reflect ERM-Q scores. The number of assays showing positive results (excluding the amphipod assay) was significantly greater when ERM-Q scores were higher ($P < 0.0005$) indicating these assays provide a quantifiable estimation of sediment toxicity. While this describes a general tendency of the bioassays to detect toxicity at stations with higher contaminant loads, these bioassays did not entirely reflect contaminant levels. The amphipod assay produced only three positive results during the current study period, all at stations with good ERM-Q scores. This, combined with a general lack of amphipod toxicity in previous surveys, indicates that this assay does not perform well in this region. The Microtox® assay was very sensitive to stations with poor contaminant conditions (detected 100% of stations with high risk ERM-Q scores) but it displayed a tendency to generate many false positive results (detected toxic conditions at 41% of stations with good ERM-Q scores; Table 3.3.3). The clam assay was not as effective at detecting poor contaminant conditions (detected 43% of stations with high-risk ERM-Q

Table 3.3.3. Number of negative and positive Microtox® and seed clam bioassay results at stations with low, moderate and high risk ERM-Q scores. False positives are considered those assays with positive results at stations with a low-risk ERM-Q, and false negatives are considered those assays with negative results at stations with a high risk ERM-Q. By combining the Microtox and clam bioassays (combined columns), the ability to correctly detect low-risk (combined = 0), moderate-risk (combined = 1) and high-risk (combined = 2) improves.

ERM-Q	Microtox®		Clam		Combined		
	-	+	-	+	0	1	2
Low-risk	156	109	240	25	141	114	10
Moderate-risk	32	58	69	21	22	57	11
High-risk	0	7	4	3	0	4	3

scores), but it also did not generate a large number of false positive results (detected toxic conditions at 9% of stations with good ERM-Q scores; Table 3.3.3). Combining the Microtox® and clam bioassay to generate a score of 0 (positive in neither assay), 1 (positive in one assay), or 2 (positive in both assays) tends to decrease rates of false positive and false negative results. 53% of stations with good ERM-Q scored 0 in the combined assays, and 96% scored a 0 or 1. 43% of stations with poor ERM-Q scored as 2 in the combined assay and 100% scored as 1 or 2. Taken together, this supports coupling these bioassays in studies of sediment toxicity such that the Microtox® assay provides the ability to more consistently detect sites that have high sediment contaminant loads while the clam assay helps to limit the number of stations incorrectly identified as toxic by the Microtox® assay.

The “false positive” rate in the toxicity bioassays may reflect the effects of contaminants not incorporated into the ERM-Q or other environmental parameters. Most of the contaminants measured by SCECAP as well as many new unmeasured contaminants in the environment have no published bioeffects guidelines. For example, station RT042266 had unusually high concentrations of two PAH compounds considered to be carcinogenic, but these contaminants could not be incorporated into the ERM-Q due to lack of bioeffect guidelines. Environmental parameters other than sediment contaminants could also contribute to station toxicity. For example, while station RO046076 possessed an ERM-Q score indicative of fair conditions, both the Microtox® and clam bioassays indicated it was toxic; this station also possessed the lowest dissolved oxygen concentration of the current study period and the highest TAN value recorded in the six years of the SCECAP study.

Integrated Assessment of Sediment Quality

The integrated sediment quality index combines ERM-Q (a measure of total sediment contaminant levels) and sediment toxicity bioassays (a measure of the bioeffects of sediment contaminants). For SCECAP, an integrated sediment quality score of < 2 represents relatively poor sediment quality, scores ≥ 2 but < 4 represent fair sediment quality and scores ≥ 4 represent good sediment quality. During the 2003-2004 study period, 25% of open

water and 28% of tidal creek habitat scored as fair while no habitat scored as poor (Figure 3.3.1). This suggests an improvement over the previous two study periods with the percent of habitat scored as good increasing from 72% to 75% in open water habitats and from 60% to 72% in tidal creek habitats (Figure 3.3.3). The large difference in the tidal creek habitats between study periods is due to a relatively small percentage (44%) of tidal creek stations receiving a good integrated sediment quality score in 2001. This same year had the highest proportion of false positive bioassay results (69%) in tidal creek habitats of any year. However, on a yearly basis, there has been no significant change in the integrated sediment quality scores of open water or tidal creek stations since the beginning of SCECAP monitoring (Fig 3.3.3).

The conflicting trends noted between the integrated sediment quality scores (which suggest improving or unchanging habitat quality) and ERM-Q (which suggest increasing contamination) likely reflect the averaging of ERM-Q and toxicity bioassay results in conjunction with a high rate of false positive and negative results among the bioassays. For example, the station with the highest ERM-Q during the current report period only scored as toxic in the Microtox® bioassay. Conversely, of the stations that scored as toxic in both the Microtox® and clam bioassays, 42% possessed low-risk ERM-Q values and only 13% possessed high-risk ERM-Q values. The result is that, once combined into an integrated score, these components average out to produce good or fair conditions at most stations. This stresses the importance of considering the individual components of the integrated scores (whether water quality, sediment quality or biological integrity) rather than relying solely upon the integrated scores for judging the state of our coastal waters.